INTERNATIONAL JOURNAL OF SURGERY 6 (2008) 214–219

INTERNATIONAL JOURNAL OF SURGERY
www.theijs.com

Postcatheterization femoral artery pseudoaneurysms: Therapeutic options. A case-controlled study

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ARTICLE INFO

Article history:
Received 11 November 2007
Received in revised form
29 February 2008
Accepted 12 March 2008
Published online 19 March 2008

Keywords:
Duplex-guided compression
Femoral artery
Pseudoaneurysms
Postcatheterization

ABSTRACT

Objectives: Postcatheterization femoral artery pseudoaneurysm is a troublesome complication following percutaneous canulations of the femoral artery. Both diagnostic and therapeutic options in the management of these pseudoaneurysms have changed dramatically, with surgery being required only rarely. We aimed to perform a comprehensive review of our experience, techniques and results in treating postcatheterization femoral artery pseudoaneurysms.

Methods: A retrospective study of all patients presenting with local complications following invasive percutaneous femoral artery canulations over a five-year period was performed. Physical examination with color Doppler ultrasound analysis identified 29 femoral artery pseudoaneurysms. Surgery, duplex-guided compression, and thrombin injection were the main therapeutic options.

Results: Fourteen cases of femoral artery pseudoaneurysms were treated by duplex-guided compression obliteration with a 78.5% success rate. Four patients had spontaneous thrombosis of their pseudoaneurysms. Five patients underwent percutaneous thrombin injection. Six patients had conventional surgery. Three cases failed duplex-guided compression: one closed with thrombin injection, and two were repaired surgically. Follow-up US showed no recurrent pseudoaneurysms for patients who underwent successful duplex-guided compression.

Conclusion: Despite the voluminous data in the literature of treating postcatheterization femoral artery pseudoaneurysms by thrombin guided injection, as a quick and effective method of therapy, with infrequent failures and complications, our study confirms the clinical usefulness of duplex-guided compression in the management of these pseudoaneurysms. The possibility of spontaneous thrombosis of small pseudoaneurysms is emphasized.

1. Introduction

As the number of arteriographies rises exponentially both for diagnostic purposes and as a treatment modality in coronary artery diseases and peripheral vascular diseases, the frequency of iatrogenic arterial injury increases as well.[1–5] Historically, the incidence of a false aneurysm after arterial catheterization was approximately 0.1%.[6,7] However, recent

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doi:10.1016/j.ijsu.2008.03.006

studies documented a marked increase in the occurrence of false aneurysms from 0.2% to 9%.[8,9] Femoral artery pseudoaneurysms (FAPs) requiring repair were seen in 1.1% of patients who underwent cardiac catheterization for diagnostic purposes and in 4.7% of patients after cardiac interventional procedures.[10] FAPs occur in 0.1–0.2% of diagnostic angiograms and in 0.8–2.2% of cases following peripheral interventional procedures.[3,6] Postcatheterization complications include bleeding, arterial thrombosis, distal embolization, arteriovenous fistula and false aneurysm formation. Early reports on the natural history of arterial pseudoaneurysms warned of the potential for distal embolization, expansion, or catastrophic rupture,[2,11,12] and recent reports have added persistent pain and compression neuropathy as associated morbidities.[1,13,14]

Clinically suspected FAP can easily be confirmed by color Doppler ultrasonography.[15–17] Surgical repair has been the traditional treatment.[16] We now know with certainty that if such lesions are left alone, spontaneous thrombosis may occur in a significant number, particularly the small ones, and especially in patients not receiving anticoagulant therapy.[5,15,18] Less invasive treatment options such as duplex-guided compression and percutaneous thrombin injection into the lumen of such pseudoaneurysms are currently considered the treatment of choice.[1,3–5,12,13] Endoluminal vascular repair with covered stents was reported as an alternative approach.[15,18]

Herein we report our experience with 29 cases of postcatheterization FAPs, focusing on the use of various closure techniques (duplex-ultrasound-guided compression, thrombin injection, and surgery). We aimed to present a comprehensive review of our experience in the management of FAP, mainly duplex-guided compression despite the current treatment of these lesions with thrombin guided injection.

2. Patients and methods

From June 2001 to September 2006, the hospital records of 8360 patients who had coronary or peripheral angiography and angioplasty were reviewed. All complications related to femoral puncture sites such as a bruit, hematoma, pulsatile hematoma, or marked pain or tenderness were studied. A color Doppler ultrasound analysis evaluated the presence of pseudoaneurysm or other complications, such as arteriovenous fistula. The clinical diagnosis in our cases was based on the presence of groin hematoma, and a pulsating mass. Color Doppler ultrasound confirmed the diagnosis in all our cases. The status of the injured vessel, the pseudoaneurysm, and the connecting tract are displayed in real time as a two-dimensional image. Criteria used to diagnose a pseudoaneurysm included swirling color flow in a mass separate from the underlying artery, color flow signal in a track leading from the artery to the mass consistent with a pseudoaneurysm neck and a to-and-fro Doppler waveform in the pseudoaneurysm neck (a retrograde flow out of the pseudoaneurysm in diastole).[12–14] Twenty-nine patients were found as having FAPs. The pseudoaneurysm vessel of origin was the common femoral artery (CFA) in 21 patients, the superficial femoral artery (SFA) in five patients, and in the remaining three patients the origin could not be determined. Although there was no specific treatment according to the different sites of FAP; the six FAPs which were treated with surgery were 5 related to the CFA and one related to the SFA; the 14 FAPs which were treated with compression therapy were 12 related to the CFA and two related to the SFA; the five FAPs which were treated with thrombin injection, three were related to CFA and two related to the SFA; and in the remaining four FAPs with spontaneous thrombosis, one was related to CFA and in three the origin of the FAP was not determined. We applied the available treatment regardless of the site of origin and the volume of the pseudoaneurysm, and we applied thrombin injection in the last five cases.

At diagnosis, 14 patients received anticoagulation therapy (LMWH) and nine received antiplatelet therapy (clopidogrel), and none of the remaining six patients received anticoagulation or antiplatelet therapy. We resume therapy by using clopidogrel when indicated. Four patients had spontaneous thrombosis of their pseudoaneurysms in the interval between discovery and treatment. These pseudoaneurysms were less than 2 cm in diameter, and neither anticoagulation nor antithrombotics were given in these four cases. Six patients underwent conventional surgery, 14 were referred for duplex-guided compression, and five patients for thrombin injection as the initial and primary therapy. Actually at our hospital, US-guided manual compression or percutaneous injection of thrombin into a non complicated FAP was considered to be the primary therapy. Surgery was considered for FAPs associated with active thigh bleeding from rupture in two patients, local ischemic skin necrosis in one patient, suspicion of infection or groin abscess in two patients, and in one patient with a large FAP with a wide ''neck''.

US-guided manual compression was performed by using the technique of Fellmeth et al.[12] The puncture site was scanned with a variety of transducers ranging from 3.5 to 7.0 MHz. to determine the anatomy of the pseudoaneurysm. The relationship of the flow lumen to the underlying pseudoaneurysm neck and artery was delineated. The soft tissues surrounding the pseudoaneurysm were searched for evidence of an arteriovenous fistula or of multiple interconnecting pseudoaneurysm lobes. After written informed consent was obtained, the transducer was oriented to demonstrate the pseudoaneurysm neck to the best advantage. Manual compression was applied to the neck for 10–20 min periods to completely arrest flow into the pseudoaneurysm. Brief intermittent release between cycles was performed to assess pseudoaneurysm thrombosis, or to reposition the transducer. Compression was continued until the pseudoaneurysm achieved thrombosis or until patient or operator fatigue compelled termination. Conscious sedation was employed by using intravenous injections of 1–2 mg midazolam hydrochloride, and local anesthesia if needed.

US-guided thrombin injection was given by using the technique described by Kang et al.[13] With transducers ranging from a 5.0 to 7.5-MHz linear-array or a curved linear-array transducer, the local anatomy was determined as previously mentioned, with patent artery and vein. The needle was preloaded with human thrombin (500 U/mL); the freeze-dried human thrombin was reconstituted with the calcium chloride solution. The needle was placed into that portion of the flow lumen where the direction of flow was away from the

pseudoaneurysm neck. Once the needle was in the flow lumen, 0.1–0.3 mL (100–300 U) of thrombin was injected over 3–5 s. Color Doppler US monitored the development of thrombosis. In cases in which there was partial thrombosis, a second injection of 0.1–0.3 mL (100–300 U) was given into the remaining flow lumen, with or without needle repositioning. The patient lay in bed with the affected leg straight for 4–6 h, with frequent groin and foot pulse examinations in both methods. The character of the dorsalis pedis and posterior tibialis arterial pulses was documented prior to, during, and after both procedures. Follow-up color Doppler US was performed 24–72 h post compression and thrombin procedures; a complete thrombosis of the flow lumen defined successful procedure. No percutaneous closure devices were used in any of our patients.

3. Results

During the study, 34 groin hematomas were identified. Twenty-nine FAPs were diagnosed, but no arteriovenous fistula was seen. Gender distribution was 19 (65.5%) males and 10 (34.5%) females, with a mean age of 58 years (range 34–72). The locations of the FAPs in the 10 female patients were seven CFA and three SFA, while their locations in the 19 males were 14 CFA, two SFA, and in the remaining three patients the location of the FAPs could not be determined.

Six of our patients were diabetics and five were hypertensive. None of the patients was denied treatment for their FAP due to medical history. Based on a mean rate of 1350 annual coronary procedures and a mean of 300 peripheral diagnostic and procedural angiograms annually, we calculated that the incidence of FAP was 0.26% and 0.09%, respectively, with a total incidence of 0.35%.

Each of our patients had one pseudoaneurysm, which was on the right side except one in the left. The time interval between insult and diagnosis ranged from within one week to three weeks. These 29 pseudoaneurysms were developed after arterial catheterization performed for diagnostic angiogram in two cases, endovascular procedures in 25 cases, and insertion of an intraaortic balloon pump in two cases. Catheter size ranged from 6 to 9.5 F; larger sizes were used for balloon pump assistance. The FAP geometry and position in relation to the artery, along with the volume of FAP, length and width of the FAP neck were documented before the procedures. Pseudoaneurysm size ranged from 2.0 to 5.5 cm in maximum diameter. The FAPs were not selected to one treatment based solely on the diameter. At the beginning of the study, we were unfamiliar with compression, and thrombin injection therapy was not available at our institute; six patients were operated upon to close the FAPs. During the study period, four cases thrombosed spontaneously, and their size was less than 2 cm in diameter. Ultrasound-guided compression obliteration was the primary mode of treatment in 14 cases, and was successful in 11 patients (78.5%) of the cases. Compression time averaged 35 min with a range of 20–45 min, and compression intervals of 10 min were used. Successful treatment required from one to three sessions (one session was defined as a series of compression attempts during one visit). Eight patients had successful compression with one session, two patients required two sessions, and one patient needed three sessions to achieve successful compression. Three patients were failed thrombosis, due to short and wide neck in two cases and anticoagulation after valve replacement and could not tolerate its reversal in one patient. These three failed cases were one thrombosed with thrombin injection and two repaired surgically. The number of patients in our study was too small to demonstrate a significant difference between patients receiving or not receiving anticoagulants, although compression time was much longer in patients taking anticoagulants. Owing to the numerous reports on the successful use of percutaneous thrombin injection to treat iatrogenic FAP,[13,19] we adopted this method more recently and successfully treated five cases primarily, and one case after failure of compression obliteration. Four patients required a single needle pass and a single thrombin injection. Two patients had only partial thrombosis of the flow lumen after the first injection and required a second injection. The injection of thrombin causes thrombosis to occur extremely quickly. There were no complications as a result of the procedure. In all cases, US showed that the femoral artery and vein were patent immediately and 24 h after the injection. The strength of the foot pulses was unchanged after injection in all cases.

All patients were rescanned 24–72 h after successful thrombosis of the FAP and they remained thrombosed. No complications attributable to duplex-guided compression or thrombin injection were noted. Ankle brachial indices were unchanged for all patients from pre-treatment to post-treatment. Follow-up, three months after the procedure revealed complete occlusion and no clinical or sonographical complications.

4. Discussion

Postcatheterization injury to the access artery is one of the commonest iatrogenic complications inflicted by modern medicine. It is agreed that the more complex the preceding invasive procedures, the higher the incidence. They occur more often in elderly hypertensive patients with calcified arteries, in anti-coagulated patients, and when improper techniques are used.[10,11] According to most reports, pseudoaneurysms occur in approximately 0.05–1.2% of all invasive arterial procedures.[20] The increased incidence today can be attributed to the use of larger caliber catheters and the greater enthusiasm for percutaneous coronary and peripheral endovascular procedures. The wide use of potent antithrombotic and anticoagulant therapy is also a causative factor. The low incidence of pseudoaneurysms in our study (0.35%) is most likely related to the fact that most coronary procedures and peripheral angiograms performed at our hospital during the first two years of the study were diagnostic rather than therapeutic procedures, and all invasive procedures were performed by senior consultants. The young age of our patients may also contribute to this low incidence. Untreated FAP can result in expansion, leakage, rupture, embolization, or compression of adjacent structures.[1,2,11,21]

Diagnosis of FAPs was achieved with Doppler US, which was performed by our radiologist. CT-angiogram was not

performed in any of our cases. All our cases of FAPs were below the inguinal ligaments. However CT-angiography might be needed in those doubtful cases or in those FAP which are proximal to the ligament that always make the echographic diagnosis problematic. In fact, CT-angiography could also give some information about the type of access to be used if surgery is needed.

Several therapeutic strategies have been developed to treat this complication. They include surgical repair, ultrasound-guided compression repair, and minimally invasive percutaneous treatments (thrombin injection, coil embolization and insertion of covered stents).[3] Operative repair has been the traditional treatment, especially for those pseudoaneurysms that are actively bleeding, are infected, or when serious underlying arterial thrombotic complications have occurred. While repair can be simple and straightforward, complications can occur, with the majority due to wound infection.[16] A 30% incidence of femoral neuralgia, and 3.7% mortality rate have also been reported with operative repair of FAP.[13,22] In our cases, only one patient developed post surgical repair wound infection.

Color flow duplex-guided compression obliteration has become the first-line treatment of pseudoaneurysms at many institutions.[12,13,23] It has been shown to be a safe and cost-effective method for achieving pseudoaneurysm thrombosis.[7,9] However, it has considerable drawbacks including long procedure time, discomfort to patients, a relatively high recurrence rate in patients receiving anticoagulant therapy, and less successful in patients with large FAP.[3,4,15] Our patients tolerated compression thrombosis without difficulty, two patients only required local anesthesia for pain control during duplex compression. Contraindications for compression therapy include limb ischemia, local ischemic skin necrosis, compromised runoff vessels, suspicion of infection or groin abscess, and inaccessible site.[12,14]

Untreated pseudoaneurysms presenting for longer than one month are thought to be resistant to compression thrombosis, perhaps due to endothelialization of the connecting track. The higher pressure required for compression of this track can lead to compromised flow or thrombosis of the femoral vessel.[12] Concurrent anticoagulation may prolong efforts to produce thrombosis, but is not a contraindication to attempted duplex-guided compression.[23] Duplex-guided compression of FAP, when applied appropriately has a low complication rate. There were no complications in our series.

The natural history of FAP following invasive arterial procedures suggests that small ones may spontaneously resolve without intervention.[2,24,25] The mean duration prior to spontaneous thrombosis was as long as four to six weeks in individuals undergoing spontaneous thrombosis. Spontaneous thrombosis occurred in four of our patients within three weeks. However, to assure that these femoral injuries resolve, follow-up color-duplex analysis was performed.

Numerous studies indicated that the percutaneous injection of thrombin with US guidance is more effective than US-guided compression repair for the treatment of iatrogenic FAP.[3,13,15,18,23] It was well demonstrated that direct injection of thrombin into the sac of such false aneurysms initiates a thrombotic process that obliterates the false aneurysm, so that the compression becomes unnecessary.[18,23,26] In many institutions, sonographically guided thrombin injection has replaced compression repair.[19,26,27] This procedure appears to be as safe as US-guided compression repair. Lonn et al. reported that ultrasound-guided thrombin injection induces a fast, effective, and safe thrombosis of postcatheterization pseudoaneurysms, and they suggested that this technique is superior to compression treatment and is recommended as the therapy of choice.[28,29] Thrombin injection may be given in pseudoaneurysms located above the inguinal ligament, which are contraindicated for compression because of the theoretic risk of intraperitoneal or extraperitoneal rupture.[15,18,26] Perhaps the biggest advantage of the thrombin injection technique is that the success rate reported in the literature has been consistently high, at an average of 97%, and it can usually be completed within several minutes.[3,4,13,23,26] Furthermore, the discomfort caused by the procedure is usually limited due to single skin puncture, and the injection itself is painless. In accordance with these facts, no conscious sedation is required.

While the thrombin injection technique has proved to be relatively easy to perform and appears to be suitable for most patients with iatrogenic FAP, there are some scenarios in which an alternative technique may be more appropriate. It seems that pseudoaneurysms with short and wide necks would be at higher risk of downstream embolization than ones with long and thin necks.[27,30] The possibility of downstream embolization emphasizes the necessity of vascular radiology and surgical coverage when these procedures are performed.[28–30] In addition, some tiny pseudoaneurysms, particularly if deeply located, may be too small to accurately puncture with a needle.[13,28] In this scenario, an alternative treatment such as compression repair or waiting for spontaneous thrombosis seems most prudent.[23,28,31] On the other hand, it has been reported that although percutaneous thrombin guided injection was more effective than duplex-guided compression and less complications were reported with thrombin injection, there was no statistically significant difference in the length of hospital stay between the two procedures.[5,28,29] A pragmatic approach may be to use duplex-guided compression as first-line treatment for pseudoaneurysms, reserving thrombin injection for failure of the procedure, and for larger pseudoaneurysms.[23] These techniques are reserved for the stable iatrogenic FAP. Prompt surgical repair is mandated in pseudoaneurysms associated with active thigh bleeding from rupture, skin ischemia, nerve compression, threatened extremity, or infection, and in patients with a pseudoaneurysm with a wide ''neck''.[4,5,11] Other nonoperative methods of treating pseudoaneurysms include placement of covered stents/endoluminal prostheses, injection of purified bovine collagen, and percutaneous injection of fibrin adhesive.[3,4,15,18]

Prevention can be achieved by proper puncture technique, site selection, and by correct post-procedure hemostatic compression with or without an external device.[32] Dedicated devices are under development to enable percutaneous sealing of the arterial puncture site by the end of the procedure, and some of them are already in the market. Further development of such devices may ultimately result in a significant decline in the rate of postcatheterization bleeding complications.[32,33]

Although our study sample is small to allow statistical analysis, our data suggest that both duplex-guided compression and percutaneous thrombin injection are safe and successful, but the latter is more efficient and more comfortable. Once a FAP has thrombosed, it remains thrombosed, thus obviating the need for repeated follow-up examination.

When one considers all of the alternative treatments described in the literature, the numerous advantages reported – namely, high success rates, low complication rates, ease of performance, short procedure times, and no radiation exposure – favor the use of US-guided thrombin injection as the treatment of choice for treating FAPs. The complication rate with this technique was strikingly low. No cases of limb-threatening ischemia were reported following thrombin injection of FAPs. Surgery is the standard method of treatment, which can be performed under local anesthesia. Surgery is the mainstay of treatment based on its rapidity, definitive results and rapidity of the recovery. But, surgery is associated with the risk of complications such as hemorrhage and groin infection and a cutaneous scar remains for life. Implantation of covered stents into the common femoral artery is still under clinical investigation and is not suitable for all cases, especially for lesions at the femoral arterial bifurcation.

5. Conclusion

Numerous suitable options exist for the treatment of FAP, and these include duplex-guided compression, thrombin guided injection, and surgery. Small size pseudoaneurysms may be observed. Biodegradable material injection and endovascular stenting are also valid options. Duplex-guided compression, if performed correctly, results in a high success rate with no complications. Ultrasound-guided injection of thrombin remains a very appealing treatment to most physicians due to the procedural simplicity. Prevention can be achieved by proper puncture technique, and correct post-procedure hemostatic compression.

Conflict of interest statement
None to declare.

Funding
None to declare.

Ethical approval
By the ethical committee at King Abdullah University Hospital, Irbid, Jordan.

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